



## Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact [support@jstor.org](mailto:support@jstor.org).

Colonel WHITTLESEY stated that the representations of Central American sculptures that he had seen were unquestionably elephantine in their character, and could not be tortured into an outline of anything human. He could not say, however, how true to the originals the copies were.

WESTERN COAL MEASURES AND INDIANA COAL.—BY PROFESSOR  
E. T. COX.

THE study which I have given to the geology of the West, has led me to conclude that the Carboniferous rocks embracing the coal beds, both of the Appalachian and Western coal fields, were formed in two great depressions that gave rise to large inland seas. These seas communicated on the south and west with the ocean, which then extended far up the Mississippi valley and covered most of the southern states as far north as the thirty-fifth parallel.

A high ridge or plateau of Silurian rocks, capped in places with the Devonian, and lying in a northeasterly direction across the states of Tennessee and Kentucky, and along the western border of Ohio and the eastern border of Indiana, separated these two seas from each other, and spreading out over the northern portion of the two latter states, extended into Pennsylvania on the east, and Illinois and Iowa on the west, forming an almost unbroken chain along their northern shores.

In these seas were formed the Sub-carboniferous rocks, and, as the water became shallow from the accumulated sedimentary material that went to build them up, a barrier was formed, which shut out the ocean and cut off the source of salt water supply. Facilitated, also, by the drainage from a large surface area, the waters of these seas became less and less brackish, and the conditions necessary for the accumulation of the coal vegetation were, in this way, brought about so gradually that many marine forms of life continued to exist and by degrees accommodated themselves to the new condition of things.

That marine forms of life are brought to adapt themselves to fresh water habitudes, under favorable conditions, has been shown by the researches of Dr. William Stimpson, who found by deep dredgings in Lake Michigan, species of marine crustacea in great abundance; and similar discoveries had previously been made of marine forms of life by dredging in the large fresh water lakes of Europe.

From this, we may readily infer that the North American lakes communicated at one time with the ocean, and that their fauna and flora, were to a certain extent brought to accommodate themselves to the gradual change from salt to fresh water.

The position of the oceans, relative to the land, and the great preponderance of water on the American continent, during the Carboniferous epoch, must have had a decided influence in modifying the temperature and increasing the humidity of the atmosphere, thereby rendering it in every way adapted to the luxuriant growth of the tropical plants which furnished the carbon so provisionally stored away in the fossil fuel, for we find that many of these coal producing plants, whose dwarfed prototypes are now confined to the tropics, flourished then as far north as the arctic zone.

There could have been no necessity for any increase of carbonic acid or other material change, as some have supposed, in the composition of the atmosphere beyond a slight increase in its humidity, and the probability is that none existed.

The two great coal fields being separated from each other from the very beginning, as I have endeavored to show, by a barrier of rocks, which present no evidence of any subsequent submergence, and which long antedate the carboniferous era, renders it difficult to comprehend how an equivalency in the coal beds of the Appalachian field, can be found in those of the West, as many of our eminent geologists have maintained.

It is true that the fluctuations in level which served to build up the various strata, may have been, and in all probability were, synchronous over the two basins, but the special requirements for the production of coal beds could hardly have proved uniform over districts so widely separated.

Though once a firm believer in the equivalency of coal seams throughout the Western coal measures, I have seen much of late to shake my faith in the possibility of determining an entire agreement in the coal beds, even in the limited area of the coal fields of Indiana.

From a marked irregularity in the thickness of the Carboniferous beds over any great extent of territory, we have good reason to believe that these inland seas, like all other great bodies of water, were of unequal depth, and consequently, did not present at all times, over their entire area, the conditions

alike favorable for the formation of coal, and that, while the ocean was excluded from the Appalachian sea, where the material for coal beds was forming. The sea on the Western side was still filled with salt water, where the sediment was accumulating which was subsequently changed to rock, and the conditions favorable to the production of coal had not yet been reached. Such a state of things will serve to account for the great discrepancy in the aggregate thickness of the strata in the two coal fields. The Appalachian, being estimated at twenty-five hundred or three thousand feet, whereas, in the Western coal field, the greatest depth will hardly exceed one thousand feet; and in Indiana, not more than seven hundred feet, if so much; though we include, in the latter estimate, every stratum from the Archimedes limestone upward.

From observations made in the Western coal field, during the past three years, extending over portions of southern Illinois, western Kentucky, and Indiana, so many errors have been found in the sections of the coal strata given in the third Kentucky Report, and which were pretty generally copied by other geologists in more recent reports, that I have found it necessary to make an entirely new classification of the coals in the west.

In the connected section of the Western coal beds, given at pages 18-24, 3d vol. Ky. Report, the measures are divided into upper and lower coal measures, and this arrangement, with some local modifications, has, until recently, been generally adopted by geologists. Now, so far as my observations go, either in Kentucky, Illinois or Indiana, I can find neither lithological nor palæontological evidence which can be relied upon for cutting up the Western coal measures into separate epochs. The Anvil Rock sandstone, which was brought into requisition for this purpose, can hardly be depended upon as a horizon, beyond the small district in which it was first discovered, and the equivalency of the Mahoning sandstone of the Pennsylvania geologists, as designated by Owen and Lesquereux, has also proved totally unreliable as a basis for division, even though it should be found necessary to establish one.

In the 3d vol. Ky. Report, and in the Report of a Geological Reconnaissance of Indiana, 1859, the latter stone is at one place referred to the horizon of the Anvil Rock sandstone, and at another locality to that of the Millstone grit.

Indeed, so unfortunate has been the effort to transplant the Mahoning sandstone of Pennsylvania into our western coal measures,

that I can recall no prominent locality where it is distinctly referable to one or the other of the above sandstones. For the equivalency of sandstones in the Western coal field I have, as yet, been unable to find any lithological or palæontological evidence which can be relied upon as a guide to identity.

In the Indiana Report by Prof. Richard Owen, 1859-60, Prof. Lesquereux refers, from palæontological evidence, the sandstone above the "Knob" coal in Spencer county, to the Mahoning sandstone, and appears undecided, whether the position of the "Martha Washington" sandstone, which forms the bluff at Rockport and presents a vertical face of thirty to fifty feet on the side fronting the river, should be referred to the Mahoning or the sandstone above coal No. 2 of his general section given at pages 299-305, (column No. 1 of diagram). At these localities, from my own examinations, I find the Rockport Sandstones to be the Millstone grit, and the "Knob" coal to be coal L of my general section of the coals in Clay county (column No. 3 of the diagram). Consequently, the sandstone which overlies it, in the hill, if referred at all to an equivalency in the Kentucky section, will be at least about the place of the Anvil Rock sandstone.

At Washington, in Daviess county, Mr. Lesquereux found a paucity of palæontological evidence, nevertheless it was believed to be sufficient to warrant him in referring the main coal of that place to No. 1, B, of his section. In his account of the measures, in Daviess county, no mention is made of the heavy bed of sandstone, two miles northeast of Washington, which is overlaid by the "Washington Coal" which he refers to No. 1, B. This sandstone is quite a marked feature in the geology of this part of Daviess county and is underlaid by two workable beds of coal—the upper three feet thick, and the lower three to six feet thick; the space between the two, varying from twenty to forty feet. The lower coal has usually a limestone over it; and being the second coal, in the descending order, below the "Washington coal" is represented as K in my section. A coal fourteen miles north of Washington, overlaid by limestone, is, from its position, referred by him to coal No. 1, C. I suppose the coal in the bed of the river below Edwardsport, in Knox county, is the seam here referred to; if so, it is the second seam below the "Washington coal." Now the "Washington coal" is at least as high up in the measures as coal L of my section. The first coal below L, in

Daviess county, was not recognized in Clay county, and at the time of making my section it was thought that no coal would be found intervening between L and K, consequently, I am now compelled to make an interpolation of a letter and provisionally designate this coal as X; the coal, with the limestone above it, as K, and the five foot coal bed near the top of the hill at Edwardsport, which is equivalent to the "Washington coal" as L.

Passing on northward into Clay county, coal I, of my section, refers to No. 1, A, and K to No. 1, C, of Lesquereux' section.

Now it is clearly demonstrated in this county that there are two workable block coal beds in a space of fifty to sixty feet below the seam reported by Mr. Lesquereux as No. 1, A, or the lowest workable seam.

At Garlick and Collins' mine, on Otter creek, in Clay county, coal K is seen in the side of the hill in the road cut; I, is worked by a drift, and G is worked by a shaft sunk at the foot of the hill on the bank of Otter creek. Both I and G are here loaded in the cars from the same coal tip.

In my first report, 1869, I pointed out the existence of a second workable seam of block coal below the seam then generally worked; its position in the column was determined from imperfect outcrops, and for a time, an error was committed in confounding it with a still lower seam F. Previous to my survey of Clay county, no other person who had examined the ground, dreamed of finding another workable bed of coal below what was called the "Brazil seam" (I). On the contrary, it was universally believed that the strata at Brazil, indicated the latter seam to be the lowest workable coal in the coal measures proper, and, consequently, that no seam of any economical value could be found below it. Since the publication of my first report, the second seam has been reached by shafts and worked at a number of localities in the county, and the existence of the third seam is fully proved by bores.

At Highland, two miles west of Brazil, L of my column, is the principal coal worked, and probably the only seam in the basin, at that locality, which is of a suitable thickness to be mined with profit.

Notwithstanding the high position which it undoubtedly occupies in the measures, we find that it is referred by Mr. Lesquereux to No. 4 of his column, the same seam at Williams' to No. 3, and the sandstone which is seen above the coal at Highland he refers,

without doubt, to the Mahoning sandstone. In fact, the misplacing of coal seams, and confounding of sandstones at all levels with the Mahoning sandstone, of Pennsylvania, and the Anvil Rock sandstone of Kentucky, I might continue to trace throughout the entire coal field of Kentucky, Indiana and Illinois. In the Kentucky reports, and the Report of a Geological Reconnoissance of Indiana, 1859, as well as in the reports of other geologists, who have written on the western coal measures, the distinguished authors appear to have satisfied themselves that the western coal beds and sandstones are synchronous with the Appalachian strata, and that the Mahoning sandstone, there a conspicuous horizon, must, as a matter of necessity, have a place in the western field, and divide here, as there, the measures into upper and lower coal measures, and that the coal beds should conform thereto.

Having pointed out a few of the errors committed in the stratigraphy of the Indiana coals, at localities where their position can be proved beyond a doubt, I will now proceed to show some of the errors that exist in the Kentucky column, from observations made at the same localities that furnished the data upon which it was constructed, and which column has heretofore served as a basis for the arrangement of the coal beds and sandstones of all other districts in the west.

The column of the coal measures given at pages 18-24, 3d vol., *Geology of Kentucky*, presents us with thirteen hundred and fifty feet of strata, above the Millstone grit or Careyville conglomerate. From the sandstone under coal No. 18, down to the Anvil Rock sandstone, there is a repetition of the strata, including the latter rock, probably as far down as No. 7. This part of the column was constructed from bores that started on the Carthage limestone, which, in Union county, Kentucky, is, I now believe, the equivalent of the limestone over coal No. 11. Though the details of strata passed through in these bores can hardly be relied upon, and in no two instances do they fully agree, as to the character of the rocks, still the place of the coals, and probably their full thickness, is given with considerable accuracy. Therefore, in the arrangement of this part of the column, it was erroneously assumed that the bottom of the lowest bore in Union county, starting from the horizon of the Carthage limestone, stopped just before reaching coal No. 11. From No. 17 down to No. 13 by ref-

erence to the diagram you will observe the close agreement in the spaces between the coals above, and those below No. 11. In the former, they are thirty-five, one hundred and two, one hundred and fifteen, and seventy-seven feet respectively, while in the latter they are forty-six, sixty-seven, eighty-six and one hundred and twenty-seven feet; the aggregate distance from No. 17 to No. 13 being three hundred and twenty-nine feet, and from No. 11 to No. 6, three hundred and twenty-six feet. In giving the space from No. 8 to No. 6, I have omitted No. 7, which, at best, is but a streak of coal, and has no existence in Union county, where the principal data for the section was obtained. We are thus carried down to about the place of the "little coal" at Mulford's, now Shotwell's mines, or No. 6 of the Kentucky column.

From No. 5, passing down, there is but one thin coal seam in the space intervening between it and Bell's coal or No. 1, B.

The Curlew sandstone that is referred to a horizon just below the Mahoning sandstone of Pennsylvania, is the equivalent of the Anvil Rock sandstone. No. 4 coal is No. 11, and No. 3 is the equivalent of No. 1, B, or Bell's coal, which lies just above the Millstone grit or Caseyville conglomerate. In Union county, Kentucky, there is a thin coal in the conglomerate below Bell's coal, but there appears to be no workable seam.

The total thickness of the strata in the Kentucky column, exclusive of the Millstone grit, is thirteen hundred and fifty feet; now strip it of the above errors of repeated strata, and we have, as the depth of the Carboniferous rocks in Union county, Kentucky, only six hundred and twelve feet, including the Millstone grit.

The above errors are, in a great measure, to be attributed to too great a reliance on palæontological evidence, and to an apparent desire to make the measures conform to the Pennsylvania sections of the Appalachian coal field.

Though there are some striking analogies, so far as relates to the character and peculiar arrangement of their accompanying rocks, which were first pointed out by myself in a lecture on the western coals in 1857, between the Pittsburgh seam of Pennsylvania, and the mammoth seam of western measures (No. 11 of Owen's, and which may prove to be K of my column), yet, from the undoubted disconnection of the two fields while the coals were being formed, it is difficult to conceive how any reliable equivalency can be established.

More especially are we led to doubt the equivalency ; if we take into account the great preponderance of coal measure strata in the Pennsylvania district, which goes to show that the conditions necessary for the production of coal extended over a much greater period of time in the Appalachian, than in the western field.

Though I have assumed that the greatest depth of coal strata in the western measures will not exceed one thousand feet, in Indiana it will not be found greater than six hundred and fifty feet, including the Millstone grit. In a few localities in this State there are one or more very thin seams of coal below the Archimedes limestone, but no coal of any economical value has yet been found lower than the base of the Millstone grit.

There are in Indiana two well defined zones of coal, the eastern and western zone, and though an equivalency in some of the seams is clearly traced, from one to the other, yet the quality of the coal is quite distinct in each.

The area of the eastern zone is about four hundred and fifty square miles, or two hundred and eighty-eight thousand acres, and the included coals belong to the bituminous variety characterized as *non-caking* or *free-burning*.

The *cherry-coal* or *soft coal* of England is a non-caking coal, but the non-caking coals of Indiana differ somewhat in physical structure from the English coal and from a similar class of coals found in the Mahoning valley, Ohio, and the Shenango valley, Pennsylvania ; the latter two being the only other localities in the United States where non-caking coal is formed in any quantity. The Indiana coal from this zone has received the local name of *Block coal* ; a name given to it by the miners on account of the facility with which it can be mined in blocks as large as it is possible to handle. The beds are crossed nearly at right angles by joint seams that greatly facilitate the operation of mining, which is usually carried on without resort to blasting. Blocks are taken out the full depth of the seam and leave a zigzag, notched outline, on the face of the mine, resembling a Virginia worm fence.

Block coal has a laminated structure and is composed of alternate thin layers of vitreous, dull black coal, and fibrous, mineral charcoal. In the direction of the bedding lines it splits readily into thin sheets like a slate, but breaks with difficulty in the opposite direction, and when struck with a hammer emits a sound

like that given by wood. Chemically it does not appear to differ from the caking-coals, but in burning behaves quite differently. Unlike the latter, it does not swell and shoot out jets of gas, nor form a cake by running together, neither does it leave an ash mixed with clinker, but retains its shape like hickory wood, until entirely consumed to a small quantity of white ash, which contains no trace of clinker. I have not yet had time to make an ultimate analysis of the block coal, but I believe that, when so examined, its superior heating properties which have been determined in practice by actual work done, though mainly due to its physical structure, will be found partly owing to its containing less oxygen and relatively more hydrogen than is commonly found in bituminous coals. The block coal, in a great majority of the mines that have been opened, is remarkably free from sulphur and phosphorus.

A specimen, taken from Garlick and Collins' new shaft, coal G of my section and which has a specific gravity of 1.232, gave in one hundred parts: Water, 2.10, Gas, 37.35, Fixed Carbon, 57.95, Ash, white, 2.40, Phosphorus, 0.22, Sulphur, 0.073.

At the White River Valley Rolling Mills, in this city, I was informed by the Superintendent, Mr. Sims, an experienced iron master from Pittsburgh, Pa., that it not only required a less quantity of block coal than of any of the coals in use around Pittsburgh to make a ton of wrought iron, but that they were likewise enabled to bring off the heats in a much shorter space of time, and the resulting iron is of a superior quality—three important advantages that cannot be overlooked by iron-masters; and it must be conceded, that the good behavior of a coal in the puddling furnace is one of the very best tests of purity and effective heating properties to which it can be subjected; for, here, its good qualities are brought into requisition, and the bad ones are soon made manifest in the poor quality of the iron produced.

Though the Blast furnaces of Clay county cannot be looked upon as filling all the requisites of an iron furnace best adapted to the use of block coal, still they are enabled to make a ton of No. 1 foundry iron that will, in quality, compare favorably with charcoal iron, by the use of less than two tons of coal; and I feel fully satisfied that by materially increasing the width of these furnaces across the bushes, and raising the temperature of the blast to 1200°–1500°, the *make* will be greatly increased and the consumption of coal very much reduced.

In the Block-coal zone of the Indiana coal field, there are as many as eight seams of non-caking coal, four of which are of good workable thickness over a portion of the field. These are I, G, F and A, which, together, have a maximum thickness of fifteen feet, and by including the other four seams, we have six feet more, making a total of twenty-one feet of block coal.

The superior excellence of the block coal for smelting, and working iron and steel, in all the varied departments of their manufacture, has been fully established by practical tests. Pig iron made with this coal is in every respect equal to charcoal iron made from the same ores; it is a soft gray iron of a highly crystalline structure, contains a large percentage of combined carbon, with but a mere trace of sulphur and phosphorus; properties which render it admirably adapted to the manufacture of Bessemer steel.

For steam and household purposes it likewise has an unrivalled reputation. It burns under boilers with a full and uniform flame that spreads evenly over the exposed surface, thus securing a more uniform expansion of the boiler plates and greater freedom from leaks that are so common when caking coals are used. No clinkers are formed, and owing to its freedom from sulphur it has but little detrimental effect upon the boilers, grates or fire boxes.

The western zone of coals in Indiana comprises by far the greatest area of measures, being somewhat over six thousand square miles, and contains three or more very thick beds of coal, besides a number that are too thin for working. Its eastern boundary, which is formed by the zone of block coal, is irregular in outline, and with my present knowledge of the geology of the country, it cannot be well defined. It is evident, however, that the block coal beds, as we go west, are changed in character and pass into caking coal. The lower members thin out, and are no longer of workable thickness, even before reaching the Wabash river. Of this we have abundant proof by the three deep bores at Terre Haute.

These bores commence about forty feet above low water of the Wabash river, and after passing a few feet of alluvium deposit, were in strata of gravel, sand and hard pan, peculiar to the drift epoch, for a depth of about one hundred and fifty feet, and though they penetrate the Silurian rocks, the records show that but five seams of coal were passed; only the top one being of workable thickness, while the lowest is but two hundred and ninety-three and three-quarters feet below the surface.

Two and a half miles east of Terre Haute, coal N, which is worked by a shaft at Seebyville, crops out; this indicates a rise of the strata to the west, and, as a still further means of accounting for the absence of the upper part of the coal measures in these bores, it is possible that the great bed of drift which is found on the east bank of the Wabash river, at Terre Haute, filled up a ravine or valley from which some of the upper coal beds were removed by abrading forces.

On the west bank of the river, coal L is mined in a number of places from shafts, thirty to fifty feet deep.

From the foregoing data, therefore, I am enabled to correct the error into which I fell in my First Report, 1869, of making the top coal in the Terre Haute bores, coal L., and now place it at least as far down as coal I.

Though from the records that were kept of these bores, it is difficult to point out the base of the coal measures, or that of the Millstone grit, with any degree of accuracy, it is, nevertheless, my opinion, that the latter epoch commenced at about the depth of five hundred feet.

This thinning out of the coal seams as we go west towards the centre of the basin, is a remarkable feature which I first pointed out in 1867. A few miles west of the Indiana line in Clark county, Illinois, bores have been made in searching for petroleum, to the depth of eight hundred feet, without passing a single workable seam of coal, and the two or three thin seams reported, in some of these bores, are in the upper part of the measures.

Judged by the dip of the coal on both sides of the river, the Wabash runs on a slight anticlinal axis, and I believe this to be the case from Attica, in Fountain county, to its mouth in Posey county, and that along its course it cuts through the same strata of rocks, from the bluffs at Merom to its confluence with the Ohio river.

Near the eastern boundary of the zone of caking coals, in Indiana, we find K and L, and sometimes N, of good, workable thickness, averaging from four to eight feet, and in one locality at Pike county, there is a bed not yet studied, but thought to be K, that attains to the thickness of ten feet or more. Taken all together, the maximum thickness of these beds may be estimated at twenty feet, and will yield an average, over the greater part of the district, of ten feet of coal. At some localities the caking coal is of

inferior quality, and largely contaminated with pyrites, which is so generally disseminated through the seam that it is impracticable, in mining, to entirely separate it from the coal. In many of the counties, however, within this zone, the caking coals will compare very favorably with the caking coals of the Pittsburgh, Pa., district.

From her geographical position, and more especially on account of the extent and value of her coal beds, and the peculiar adaptation of this coal to the metallurgy of iron and steel which now forms one of the leading industries of the world, we can safely predict for Indiana a bright future as a manufacturing state. The commerce of the new far west, which is increasing with a rapidity unprecedented in the growth of empires, will just as naturally look to Indiana for its supply of iron and steel, with which to keep up the system of railroads traversing the great plains to the Pacific Ocean, as the old west formerly looked to Pennsylvania. In Indiana we find the last great belt of timber, suitable for manufacturing purposes, and after crossing her borders, thence to the Pacific ocean, no coal has yet been found that can successfully be used in the manufacture of iron.

Professor A. H. WORTHEN remarked, we have found the same difficulty in Illinois in reconciling our section of the Coal measures strata with those of Kentucky, that has been alluded to by Professor Cox, in the paper just read, as occurring with him in Indiana. On attempting to synchronize our coals with those of Dr. Owen's published section, I very soon found that it could not be done, and that if the Kentucky section was correct, no parallelism could be drawn between them. From further examinations I became satisfied that the Kentucky section was erroneous, and that by giving distinct names to different outcrops of the same sandstone, in its outcrops at different localities, they had duplicated the number of their workable coals, and also the thickness of the coal strata. This was shown in the first chapter of the third volume of the Report on the Geological Survey of Illinois, published in 1866, where, by placing these two sandstones on the same geological level, it was found that the strata underlying them formed sections, as nearly identical as they could be made anywhere in the coal series, at points twenty miles asunder. By reducing their section in this way, we find there a general correspondence between the strata in Illinois and Kentucky, as nearly complete, perhaps, as could be expected in opposite portions of the same coal-field. The coal-seams of Western and Northern Illinois are usually continuous over large areas, as much so indeed as the limestones, shales, and sandstones, with which they are associated.

Professor SWALLOW remarked that he had greatly enjoyed the examina-

tion of the Indiana "Block Coals." He believed they would become sources of vast wealth. But his friend Prof. Cox must not be sure other states would not furnish the same quality of coal.

He had for many years burned a coal which is so much like Indiana Block Coal, that Prof. Cox himself could not distinguish them.

But no opportunity had been offered for publishing the results of the Missouri Survey.

NUMERIC RELATIONS OF THE VERTEBRATE SYSTEM.—BY DR. T. C. HILGARD.

THERE are five (not four only) complete neural rib arches to the cranium of all vertebrate animals, to wit: (1) The condylar or sensitive belt with the condyle plates for side ribs and the lower arch of the *transversely bipartite* occiput for its vault piece; (2) the petrosal or *acoustic*, containing the auditory nerves in its side beams (easily detected by removing the ear drum of Felines, etc.), and overarched by the anterior belt of the occipital squama; (3) the parietal belt originally containing the true gustative nerve of fixed tastes (sour, sweet, salt and bitter, the glosso-pharyngeal), in an incision; from which it is, however, soon crowded out by the internal carotid artery and the overlapping "acoustic rib blade." The next (4) is the optic or frontal, visibly succeeded, in fishes, by (5) the ethmoidal or olfactory vertebra. The rest of the cranium is formed by its "extremities" or prehensile appendages.

The same numeric law which pervades the entire vegetable kingdom reoccurs in the human fabric in a very marked manner.

The number of "radiating elements" in a coil or whorl, or of whorls in a cycle, or in cycles generally speaking, as in pine cones and flower buds, etc., are the following:

1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, etc., progressing by the summation of the last two numbers.

The bands or parallel coils of flowers or scales in pine cones, sunflower discs, etc., embody these numbers successively, as they grow steeper and steeper, alternately on the right and left. The vertical bands, or columns, give the number of parts of the cycles involved.

The explanation heretofore given by me is this, that one element generates the other.

The elements are radial; they are bilateral rays, with a rift, so to speak, on the opposite side. It is there, where, in a like manner